PLANET C 5.0

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Introduction

PLANET is an application in which your Macintosh computes the coordinates of the planets visible to the naked eye (Mercury, Venus, Mars, Jupiter and Saturn), the sun and the moon. The coordinates are given in three different coordinate systems: the *geocentric ecliptic* and the *equatorial* and *horizontal* systems of the observer. Further you will see the magnitude of the planets and the phase of the moon and also sidereal time, mean solar time and the equation of time.

Finally when a solar or lunar eclipse is possible you can also investigate the eclipse from any place on earth.

Start the application by clicking on the PLANET icon. The screen will display a data table showing current positions of the sun the moon and the planets on the screen. Altitude and azimuth data do *not* have refraction included.

Setting time and location

At the top of the screen you will see the *space-time bar*. You can change the numbers in the bar by clicking on the digits. If you click in the lower part of a digit it will increase by one unit, clicking in the upper part will decrease it. Likewise, you can change your location from the northern to southern hemisphere and from longitude east of Greenwich to west of it by clicking on the respective letters. Note that time is *Universal Time* (GMT).

Style G means *Gregorian calendar* (the normal). By clicking you can switch to *Julian calendar* (J) which was used before about 1600. By clicking in front of the first digit in the year you can make the year negative. Remember that 1 BC = 0, 2 BC = -1 and so on.

As soon as you make a change in the space-time bar a note **Space-time changed** will appear on the screen below the space-time bar. This is to warn you that the data in the table is not longer valid for the changed space-time bar setting.

Computing a new table

Having chosen a place in space-time, you select **Table** from the **Compute** menu. You will now get a new table of the location of the sun, the planets and the moon for the selected space-time. Bodies above the horizon (refraction included) will have data written with fat letters. The last column of the table displays the magnitude i.e. the brightness of the respective planet. For Saturn it includes the effect of the rings.

For the moon, a number indicating the phase of the moon is displayed. The convention for the phase of the moon is that 0 = new moon, 1 = full moon. Negative phase numbers means decreasing phase, positive means increasing. Below the number, the phase of the moon is shown pictorially.

The moon will have additional numbers in its R.A. and Declination columns. The upper pair is *with* parallax included (i.e. as seen from the observers location on earth, the lower pair is *without* parallax (i.e. as seen from the centre of the earth).

The sidereal time and the mean solar time are given in hours and minutes, the equation of time in minutes and seconds. The *ulian day* is used in chronological work. It begins at Greenwich *noon*. Day 0 is the day starting at noon on BC. 4713, January 1.

Times for sunrise and sunset are calculated by the program by clicking on the small arrows beside the sun icon at the bottom of the screen. By clicking on the sun icon itself you may switch between times calculated for the centre or the upper limb of the sun in the horizon. In the latter case refraction is included. For latitudes above 60_ the calculation may be in error with minutes or more.

By clicking on the icon to the right of the sunset/sunrise icons you can switch between *decimal* and *sexagesimal* data representation of data. In the sexagesimal mode, rectascension is displayed in hours, minutes and seconds. There is also one icon which can be clicked to switch between azimuth origin north or south. Data representation and azimuth origin settings will be saved in a resource file and used as default settings until changed.

Eclipses

In the **Compute** menu you can check the **Eclipse Table** option. When you now run **Table** you will also get an *eclipse table* showing the possible eclipses during the current year. The eclipse symbols beside the dates indicate the eclipse magnitude. In a rather self-evident way is shown: partial eclipse, total eclipse, and annular central eclipse. (Computing the eclipse table takes quite a time on a Mac without 881 processor.)

Clicking in the eclipse table on one of the eclipses will transfer that eclipse date to the space-time bar. Also the time for the middle eclipse will be determined and a new table is computed

with these settings. Now choose the **Eclipse** option in the **Compute** menu. You will get a picture of the eclipse as seen from the current location. In the case of a solar eclipse it might not be visible from the current location as the appearance of a solar eclipse depends on the moon parallax at the position of the observer. On the other hand a lunar eclipse looks the same for all observers, but of course it has to be above the observer's local horizon in order to be seen. By changing time and location you can investigate the eclipse, its duration, and magnitude. As the moon and the sun are drawn to correct scale you will also be able to see if the solar eclipse is annular or not.

NOTE: The screen may be saved as a MacPaint-document by pressing -Shift-3 at the same time.

Transits

Transits of Mercury and Venus may be investigate in the same way as eclipses by choosing **Transit** in the **Compute** menu. This is not enabled unless the respective planet is within 0.3 degrees of the solar centre. A transit icon is then displayed to the left of the planet's name.

Transits of Mercury during 1900:

1907 Nov 14	1914 Nov 7	1924 May 7	1927 Nov 10	1937 May 11
1940 Nov 11	1953 Nov 14	1957 May 6	1960 Nov 7	1970 May 9
1973 Nov 10	1986 Nov 13	1993 Nov 6	1999 Nov 15	

Some transits of Venus:

1882 Dec 6	2004 June 8	2012 June 6	2117 Dec 11

There is a repeating cycle for the Venus transits intervals of 121.5, 8, 105.5, 8 years.

For more accurate work you should add a correction to the transit times because of the finite time for light to reach the observer. The correction is +5 minutes for Mercury and +2 minutes for Venus.

Locations

The menu **Location** holds fifteen locations on earth that can be chosen. The coordinates of this location is then inserted in the space-bar. Locations can be edited by pressing at the same time as you choose the location. This will display a dialog where location name, longitude and latitude can be edited. Location name length is limited to a maximum of 20 characters.

Animation

When you are in the **Eclipse** or **Transit** mode you can start an animation from the **Animation** menu. This will automatically step forward in time, the time increment is 2 minutes for eclipses and 5 minutes for transits. The animation is stopped as you click the mouse button or when the angular distance has become too large.

The map

In the **Go** menu it is also possible to select **Map**. This option will open a world map window. The map displays the *terminator*, the border between night and day. The day region shows a white circle over the place on earth where the sun is in zenith. If you have chosen the **Map** option with the space-time bar set for a *total* or *annular* solar eclipse, the map will display a curve on the earth's surface where the eclipse is central.

A flashing cross indicates the current location on the earth. Clicking on the map will change the position. When you leave the map (by clicking on the **Done** button) a new table (or eclipse picture) will be computed according to the position setting.

You may save a copy of the map by clicking the **Save** button or -Shift-3.

Default settings

By choosing **Restore** in the **Defaults** menu you will set the space-time bar to the current default location on earth and the current UT time and then compute the result.

To change the default location, set the latitude and longitude of your Macintosh in the space-time bar. Selecting **Set Place** from the **Defaults** menu will make this latitude and longitude the start-up/restore location.

To change the default UT time difference, set the correct current UT (to within half an hour) in the space-time bar. Remember that you may have to change the date also if you pass 0 hours. Then select **Set UT** from the Defaults menu. The program will compute the integral hour time difference between UT and the internal clock and save the result. Subsequent runs or Restore will start with the correct current UT.

Quitting

You quit by selecting **Quit** from the **File** menu.

Accuracy

The epoch of the program algorithm is January 0.5, 1900. For the moon the algorithm in *Improved Lunar Ephemeris*was used, retaining terms larger than 5" in the tables. This gives an

error in the moon position which normally is less than 10". For the other bodies, except Jupiter and Saturn, the algorithm in

Pierre Bretagnon, Jean-Louis Simon:
Planetary Programs and Tables from -4000 to 2800
ISBN 0-943396-08-5

was used. The error is also here less than 10" except for Mars where it is of the order of 20" for modern times. For times ±1000 years from now this error may be of the order of 1' and increases quadratically with time. For times not too distant from that (some hundreds of years) you can thus expect the accuracy shown in the table. Jupiter and Saturn have a much larger error, for modern times about 0.1 degrees due to long period perturbations which are not included and considerably larger errors for distant epochs. Eclipses are normally accurate to within a minute. The program should not be used for dates before 2000 BC or so. The magnitude of Saturn includes the effect of its ring system.

It should be noted that the application does not use Ephemeris Time externally but Universal Time that will give the correct "apparent" time at the epoch considered. This makes little difference for recent epochs but is convenient when studying ancient eclipses. For the sun, the moon, Mercury, Venus and Mars, ephemeris time is used in the internal calculations. The program uses the conversion formula

$$ET - UT = (24.3 + 72.3\ T + 30.0\ T2) \text{ seconds}$$

where T is the time in Julian centuries since January 0.5 1900. The coefficients in the formula may change in the future, therefore they are stored, multiplied by a factor of 10, as integer strings in the STR resources 1007, 1008 and 1009.

Help

Planet 5.0 supports help balloons under system 7.0. With help balloons activated you can move the cursor on the screen and get information on the clickable areas.

About the application

This package includes the color version of planet: PLANET C . The program needs a math coprocessor and is intended to run on a machine with color display. The source code of the applications was made in THINK Pascal. You should use a system 7 or later.

PLANET is shareware. On the condition that this documentation is included it may be freely copied and used for a period of ten days. If you intend to keep PLANET after that, you send $25.00 to me.

Application history

Version 3.3.

Version 3.4 adds possibility to save the map and displays sunrise and sunset times. The user may choose decimal or sexagesimal representation from the default menu and also switch between azimuth origin north/south.

Version 3.5 computes directly the sunrise and sunset times by clicking on icons on the screen and produces a new table. Sunset and sunrise may be calculated for the sun centre in the horizon without refraction or the upper limb touching the horizon with refraction. Also decimal/sexagesimal switching is handled by clicking icons on the screen. A bug in the conversion decimal to sexagesimal routine is fixed. Balloon help is included under system 7.0. A more sophisticated **bout Planet** dialogue is added.

Version 4.0 uses improved algorithms for the sun, the moon, Mercury, Venus and Mars based on ephemeris time. Using ephemeris time makes it necessary to convert this to UT which is done by the standard formula above. In order to accommodate future changes in this formula the coefficients are stored in resources. Version 4.0 also includes possibility to study transits of the inner planets. A editable menu with standard locations is included. Animation of eclipses and transits is possible.

Version 4.1. Window dragging is supported. A bug in the location menu is fixed.

Version 5.0. A bug in the moon algorithm fixed.

Version C 5.0. Color is included. This version only runs on machines with 68020 or higher and an 881 FPU processor.